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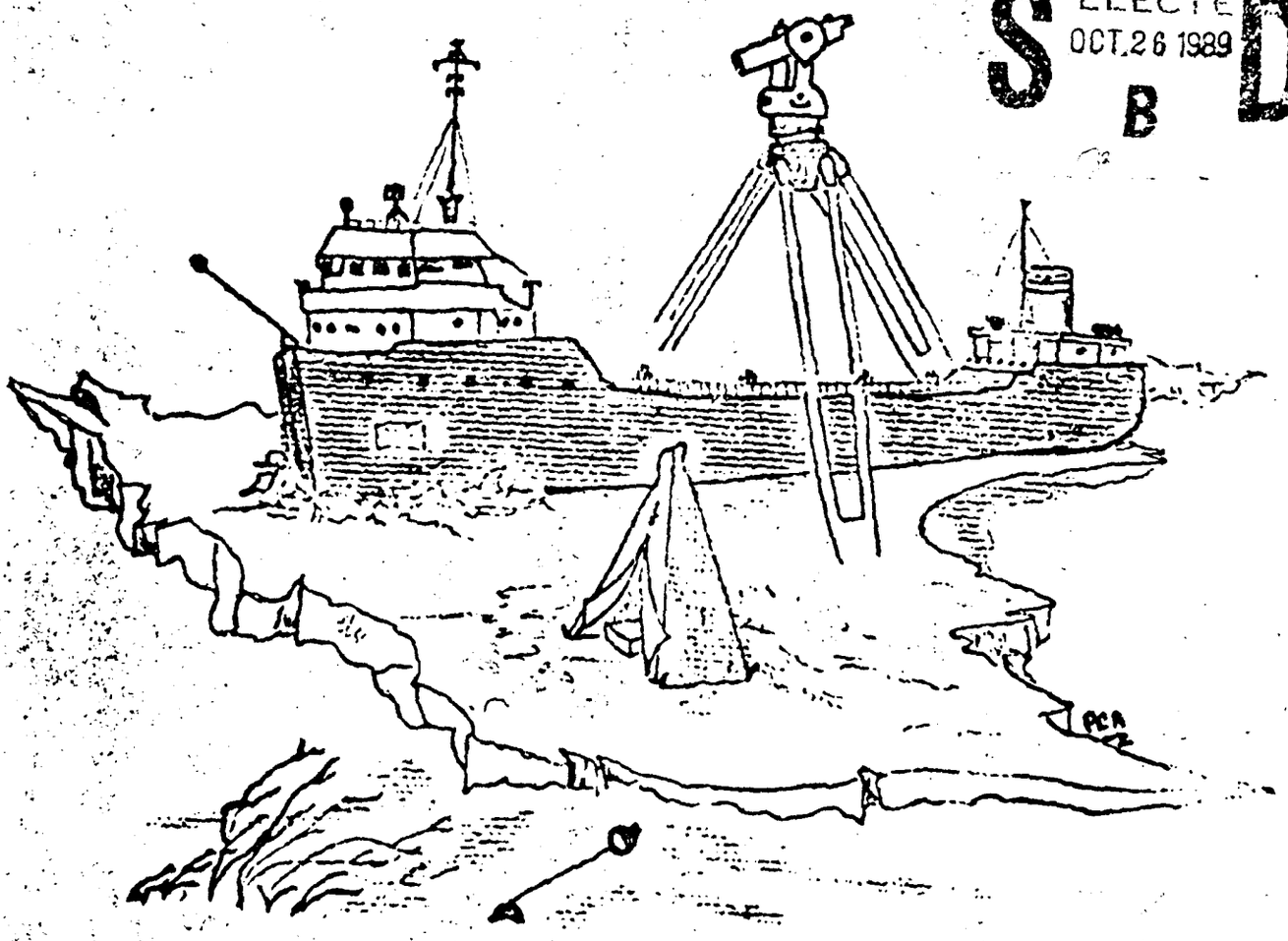
A STUDY OF ICE RELATED SEDIMENT TRANSPORT and SHORELINE EROSION

ST. MARY'S RIVER - SAULT STE. MARIE, MICHIGAN.

VOLUME 5



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Between 1976 and 1979, various field measurements were made at three sites located along the St. Marys River. These measurements, together with details of site location and range line arrangement, are contained in four volumes. The sites are referred to as the Sugar Island Site, the Adams Site, and the Nine Mile Site. This report, Volume V, contains the findings of limited continuation of the work performed and reported in the previous four volumes, and covers the winter of 1979-80. The previous reports contain information gathered from the sites during periods with winter navigation: this report provides similar types of measurements for a period without winter navigation.

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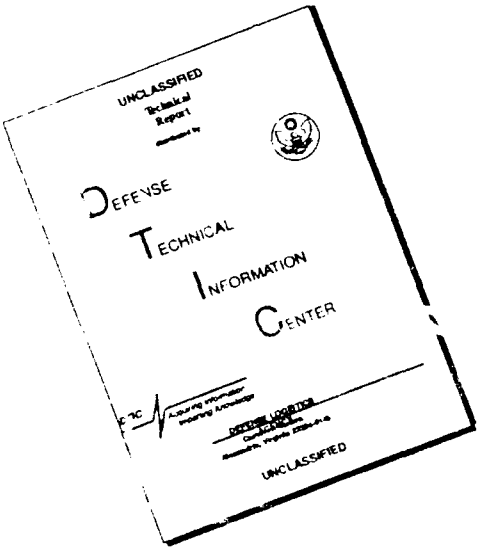

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FIELD STUDY OF THE EFFECT OF ICE ON SEDIMENT TRANSPORT AND SHORELINE EROSION

ST. MARYS RIVER, MICHIGAN

CONTRACT NO. DACA89-80-M-0795

SUBMITTED TO: U. S. ARMY COLD REGIONS RESEARCH
AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE

SUBMITTED BY: GEORGE R. ALGER, PHD
WATER RESOURCES CONSULTANT

AUGUST 1980

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AUTHORIZATION

This technical report if provided as a summary of the work performed for U. S. Army Cold Regions Research and Engineering Laboratory under Contract #DACA89-80-M-0795 concerning ice thickness profiles and river bottom profiles at selected sites along the St. Mary's River.

INTRODUCTION

Various field measurements have been made at three sites located along the St. Mary's River since 1976. These measurements have previously been reported to CRREL in a series of reports containing four volumes. Details of site location and range line arrangement may be found within these four previous reports. The three sites have commonly been referred to as the Sugar Island Site, the Adams Site and the Nine Mile Site.

This report contains the findings of a limited continuation of the work performed and reported in the previous four volumes and covers the winter of 1979-80. It is important to note here that the previous reports contain information collected at the three sites during periods with winter navigation whereas this report for the winter of 1979-80 provides similar types of measurements for a period without winter navigation.

SCOPE AND PROCEEDURES

The contract scope of work included measurements of ice thickness profiles, river bottom profiles and location of 'active' cracks along selected ranges at each of the three sites during three periods spaced within the winter of 1979-80. 'Active' cracks for the purpose of this investigation are defined as visibile separations in the river ice cover with open water within the crack.

Range lines had perviously been established (normal to on shore base lines at each site) and form more or less normal transects of the river cross section. The location and arrangement of these base and range lines have been previously reported to CRREL in the earlier reports.

During periods of ice cover holes were drilled through the ice at selected locations along several range lines and ice thickness and river bottom elevation were measured at these known locations. Any visible crack patterns were also noted during the periods of field measurements. River bottom elevations were determined by wading the range lines utilizing conventional survey equipment after the spring breakup.

RESULTS

ICE THICKNESS PROFILES AND ACTIVE CRACKS

Ice thickness measurements at the three sites are reported in TABLES 1 through 8. The profiles were continued along the various ranges until it was considered to be unsafe for personnel to move further offshore.

In general ice thickness tended to decrease offshore which is primarily due to the faster river currents present near the navigation channel. Also, while this was a study period of essentially no winter navigation there was still some limited ice-breaker activity from time to time during the winter of 79-80 and this caused some ice disruption in mid channel on occasion.

As noted within the TABLES presenting ice thickness measurements there were no active cracks noted at the Adams Site, only a grounded shore crack at the Sugar Island Site, and only on 1/31/80 was an active crack evident on one of the ranges at the Nine Mile Site. Such active cracks were commonly reported at all sites during previous years with winter navigation.

OFFSHORE BOTTOM PROFILES

Offshore bottom profiles were obtained at the locations noted for ice thickness measurements in TABLES 1 through 8. These bottom elevations were compared with those previously reported for the earlier studies and no change was noted considering the accuracy of the meas-

TABLE 1 Ice Thickness and Crack Patterns at Adams Site

Range B

DATE	1/31/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	0.7	1.3	Fast grounded
150	0.7	1.2	shore ice to
160	0.7	1.2	a distance of
180	0.8	1.3	20 feet off-
200	0.7	1.2	shore.
220	0.9	1.3	Some drifting
240	0.9	1.3	pans offshore
260	0.9	1.1	of the fast
270	0.9	1.3	ice.
280	0.8	1.0	
290	0.9	1.2	
300	0.9	1.3	
320	0.9	1.0	
340	0.9	0.9	
360	0.7	0.8	
380	0.9	0.8	
400	---	0.6	
420	---	0.6	

(NOTE) No active parallel shore cracks - clear black ice - 2 inches snow on ice (1/31/80) - 6 inches snow on ice (2/26/80)

TABLE 2 Ice Thickness and Crack Patterns at Adams Site

Range E

DATE	1/31/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
200	0.8	1.3	Fast grounded
250	0.7	1.3	shore ice to
300	0.7	1.1	a distance of
310	0.8	1.2	20 feet off-
320	0.9	1.2	shore.
330	0.9	1.2	Some drifting
340	0.8	1.2	pans offshore
350	0.9	1.1	of the fast
400	0.9	1.0	ice.
450	0.9	0.9 (slush on ice)	
500	0.9	---	

(NOTE) No active parallel shore cracks - clear black ice - 2 inches snow on ice (1/31/80) - 6 inches snow on ice (2/26/80)

TABLE 3 Ice Thickness and Crack Patterns at Adams Site

Range J

	1/31/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
200	0.9	1.3	Fast grounded
250	0.8	1.3	shore ice to
300	0.8	1.3	a distance of
320	0.9	1.2	20 feet off-
340	0.8	1.2	shore.
360	0.8	1.2	Some drifting
380	0.8	1.2	pans offshore
400	0.8	1.2	of the fast ice.
450	0.9	0.9 (slush on ice)	

(NOTE) No active parallel shore cracks - clear black ice - 2 inches snow on ice (1/31/80) - 6 inches snow on ice (2/26/80)

TABLE 4 Ice Thickness and Crack Patterns at Sugar Island Site

Range 0

DATE	2/1/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	0.8	open water	open water
200	0.8	to shore	to shore
250	0.8		
300	0.6 (some brash		
320	1.0 and snow ice)		
340	0.7 "		
360	0.8 "		
380	0.6 "		
400	0.7 "		

(Note) 2 inches snow on ice - no parallel cracks offshore - active parallel shore crack 20 feet out from base of bluff (2/1/80)

TABLE 5 Ice Thickness and Crack Patterns at Sugar Island Site

Range 7

DATE	2/1/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	0.8	open water	open water
150	0.8	to shore	to shore
200	0.8		
220	0.8		
240	0.4 (brash)		

(Note) 2 inches snow on ice - no parallel cracks offshore - active parallel shore crack 20 feet out from base of bluff (2/1/80)

TABLE 6 ICE THICKNESS AND CRACK PATTERNS AT SUGAR ISLAND SITE

RANGE 15

DATE	2/1/80	2/26/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	0.4	open water	open water
120	0.6	to shore	to shore
140	0.6		
160	0.8 (brash)		
---	unsafe		

(NOTE) 2 inches snow on ice - no parallel cracks offshore - active parallel shore crack 20 feet out from base of bluff (2/1/80)

TABLE 7 Ice Thickness and Crack Patterns at Nine Mile Site

Range 2

DATE	1/31/80	2/27/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	1.0	1.5	grounded shore
200	0.9	1.3	ice sheet for
300	1.0	1.3	a distance of
400	1.0	1.3	approximately
500	1.0	1.3	100 feet out
560	1.1	1.1	from shore.
580	0.9	1.1	
590	active crack	---	
600	0.8	0.8	

(NOTE) 2 inches snow on ice, evidence of snow covered broken pans along entire Nine Mile location (both ends) about 200 to 300 feet offshore 1/31/80 - No active cracks (2/27/80)

TABLE 8 Ice Thickness and Crack Patterns at Nine Mile Site

Range 7

DATE	1/31/80	2/27/80	3/29/80
Distance (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)	Ice Thickness (ft.)
100	1.3	1.9	Grounded shore
150	1.1	1.6	ice sheet for
200	1.0	1.5	a distance of
220	1.0	1.6	approximately
240	1.0	1.4	100 feet out
260	1.0	1.4	from shore.
280	1.1	1.4	
300	1.0	1.4	
370	1.0	1.3	

(NOTE) 2 inches snow on ice, evidence of snow covered broken pans along entire Nine Mile location (both ends) about 200 to 300 feet offshore (1/31/80) - No active cracks(2/27/80)

uring technique.

NEAR SHORE BANK AND BOTTOM PROFILES

These profiles were measured in May of 1980 by wading using conventional survey equipment. The profiles were measured along all ranges at each of the three sites.

The profiles measured at the Adams Site were compared with profiles reported in the earlier studies. The last report, Volume 4 of 1979, indicated some change at Ranges I, J, and K due to local construction. The measurements made under this contract showed no further alteration of these three profiles nor any changes in any of the other range profiles. It would appear considering the history of these measurements that no serious erosion is occurring at this site.

Nearshore profiles at the Sugar Island Site are reported in Figures 1 through 6 for all fifteen ranges located at this site. Bank and bluff recession is evident at all of the range locations. This site has been active in the past periods of study which might have led to suspicions of the effects due to winter navigation, however, these nearshore alterations appear to continue during a period with essentially no winter navigation.

Profiles measured under this contract at the Nine Mile Site were compared with those reported in previous study periods. The profile measurements reported for earlier years have shown no change except for the inshore and offshore migration of a small berm near Range 5. The results of this study, however, showed nearshore alterations at all ranges except Range 3. These profiles are illustrated on Figures

FIGURE 1

SHORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE

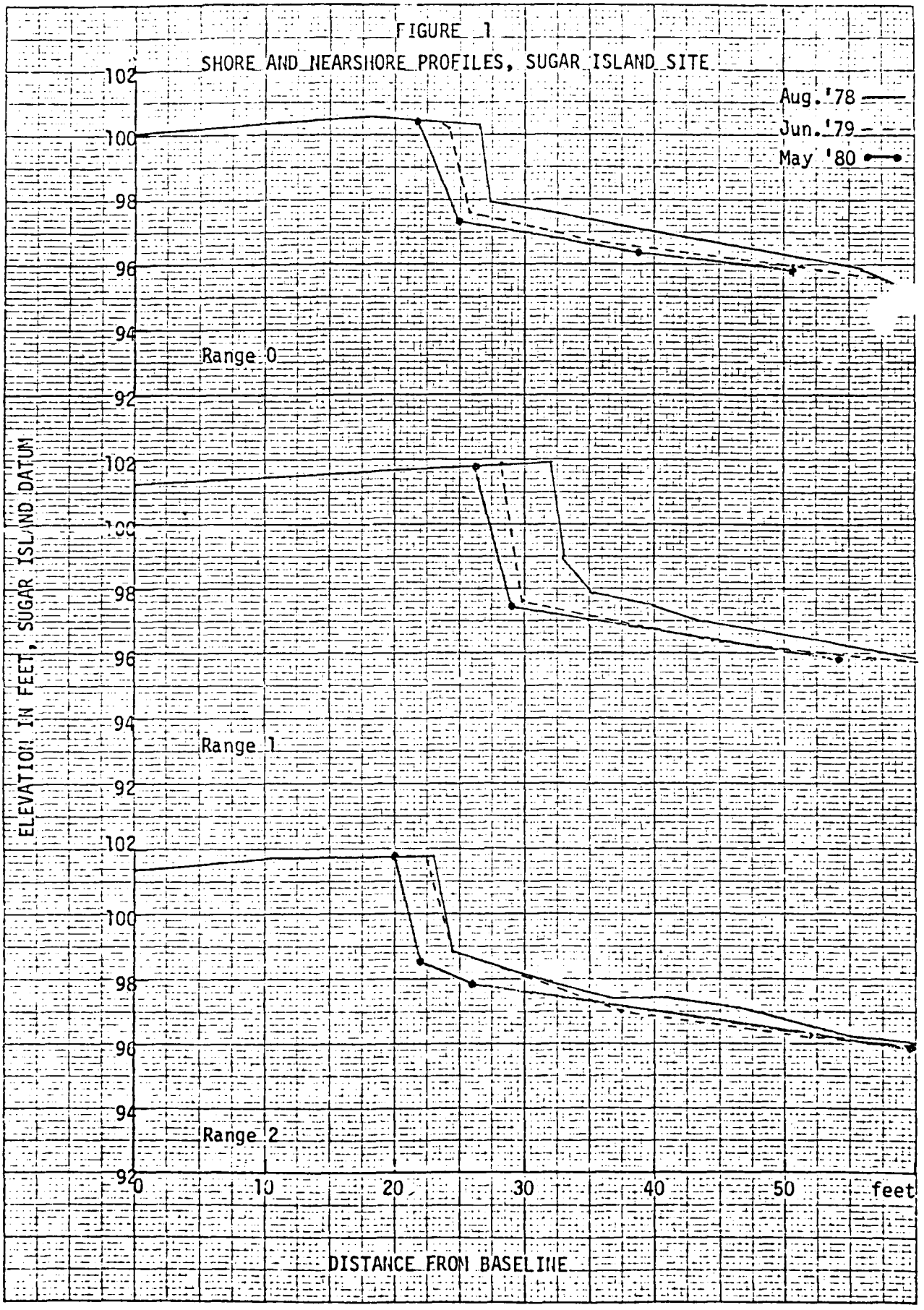

FIGURE 2

...ORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE

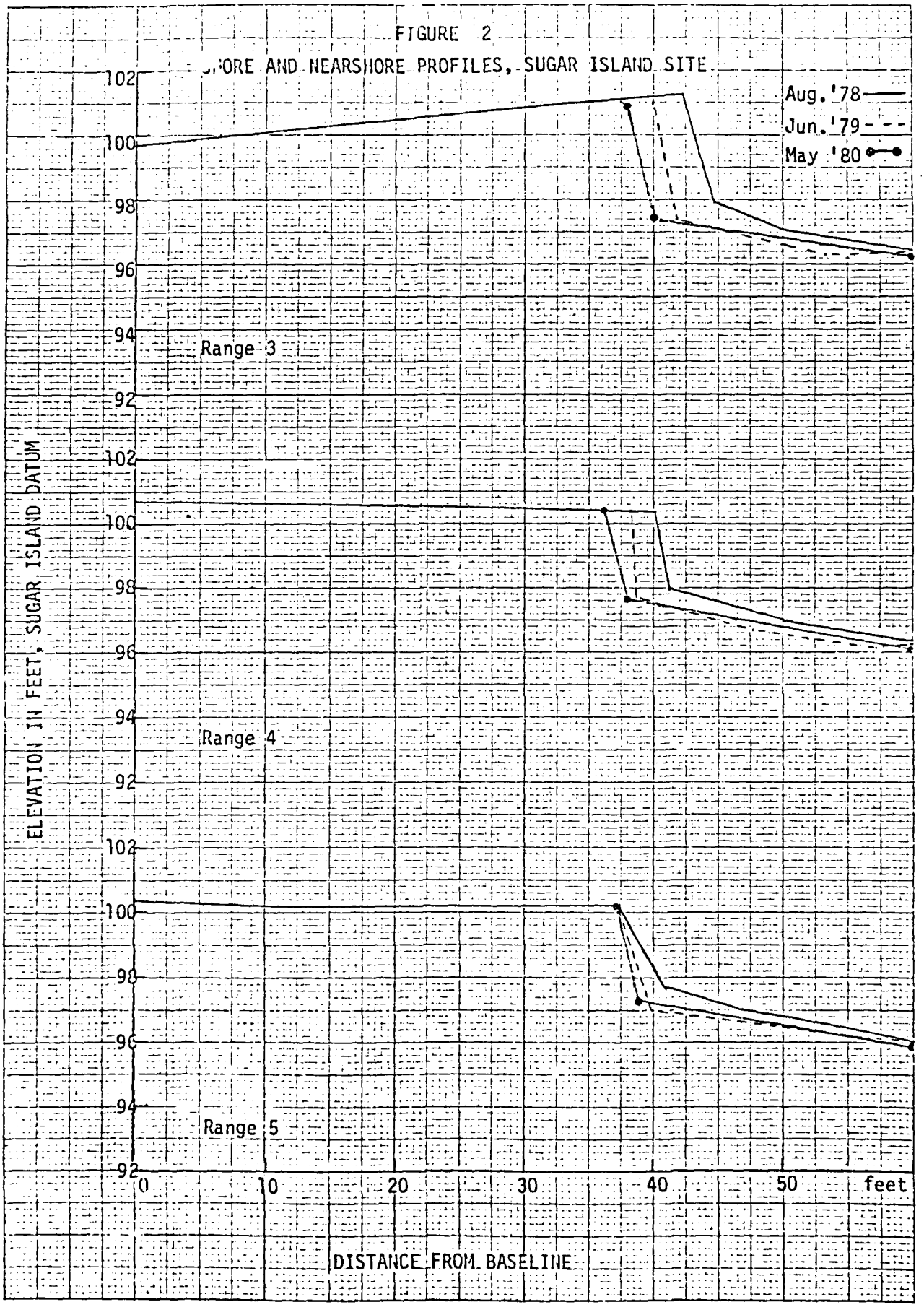

FIGURE 3

SHORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE

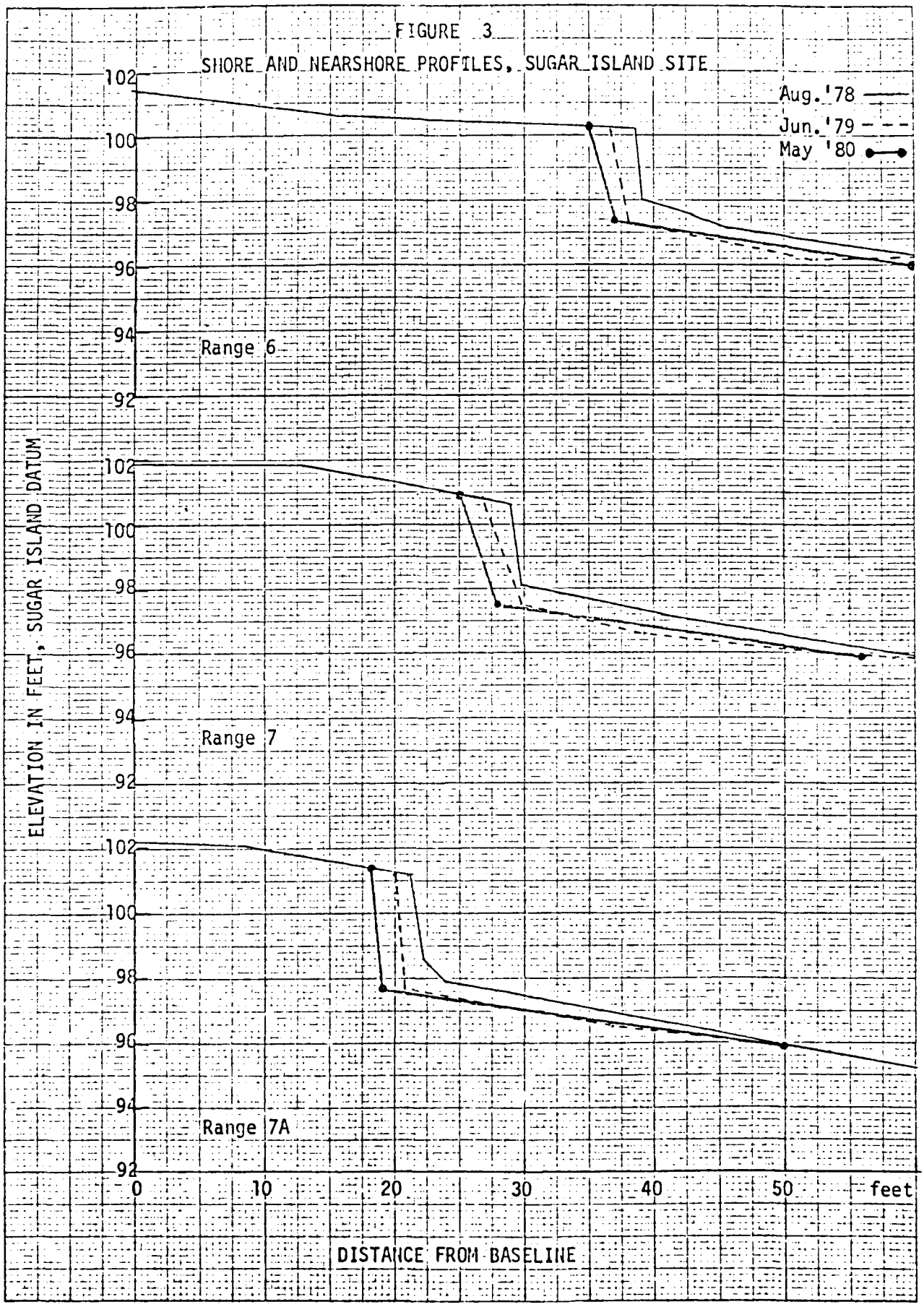

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FIGURE 4

SHORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE

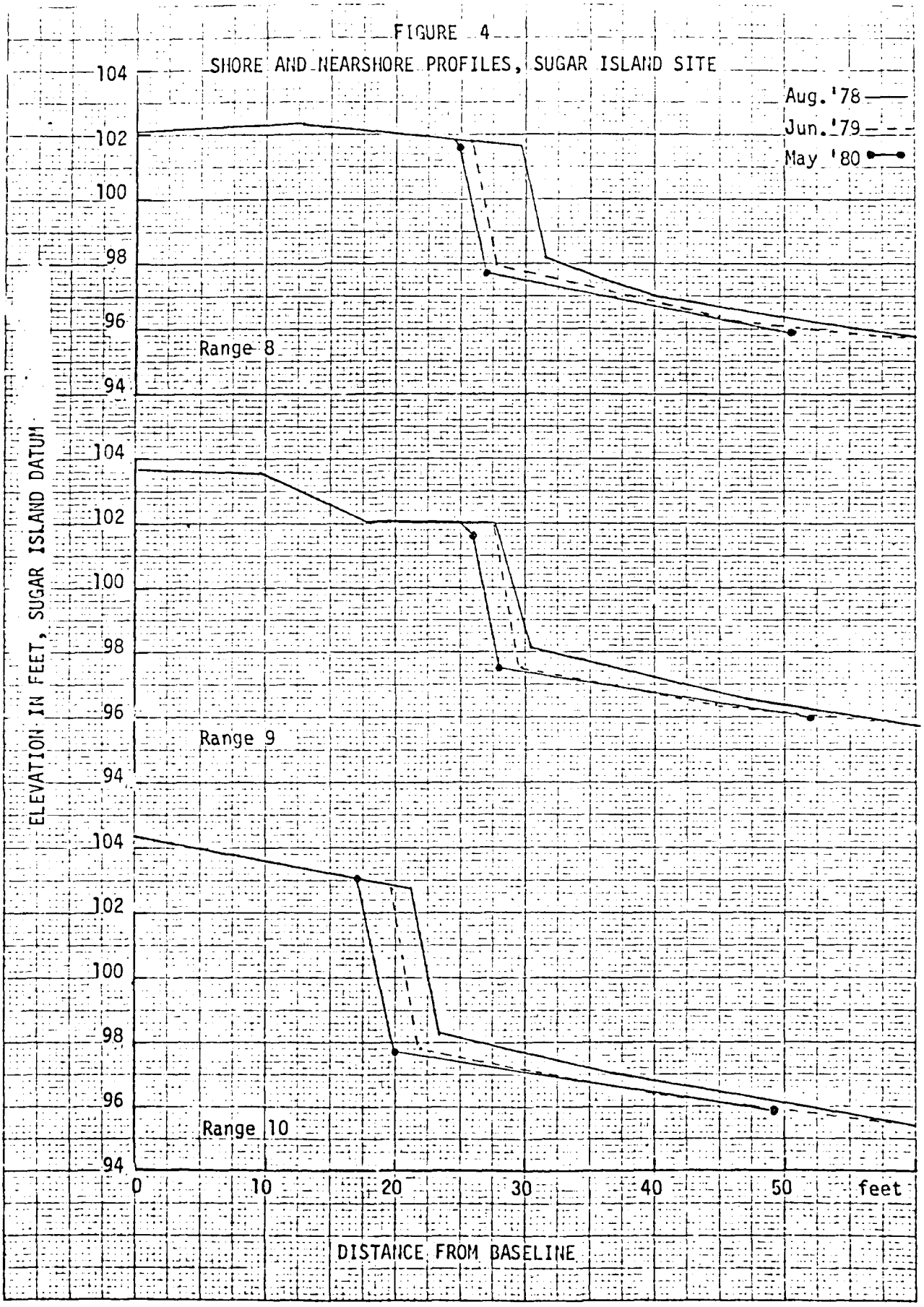

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FIGURE 5

SHORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE

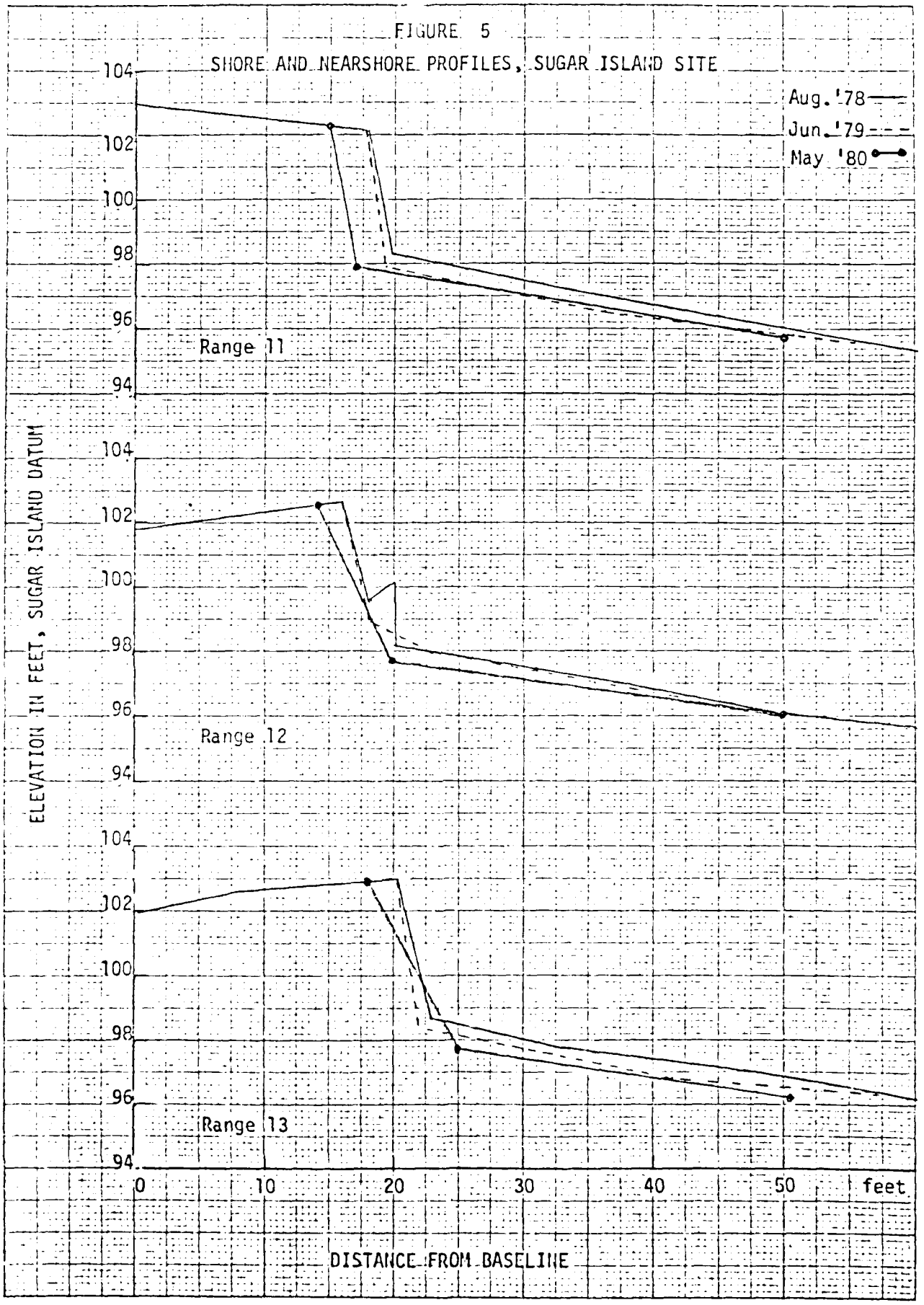
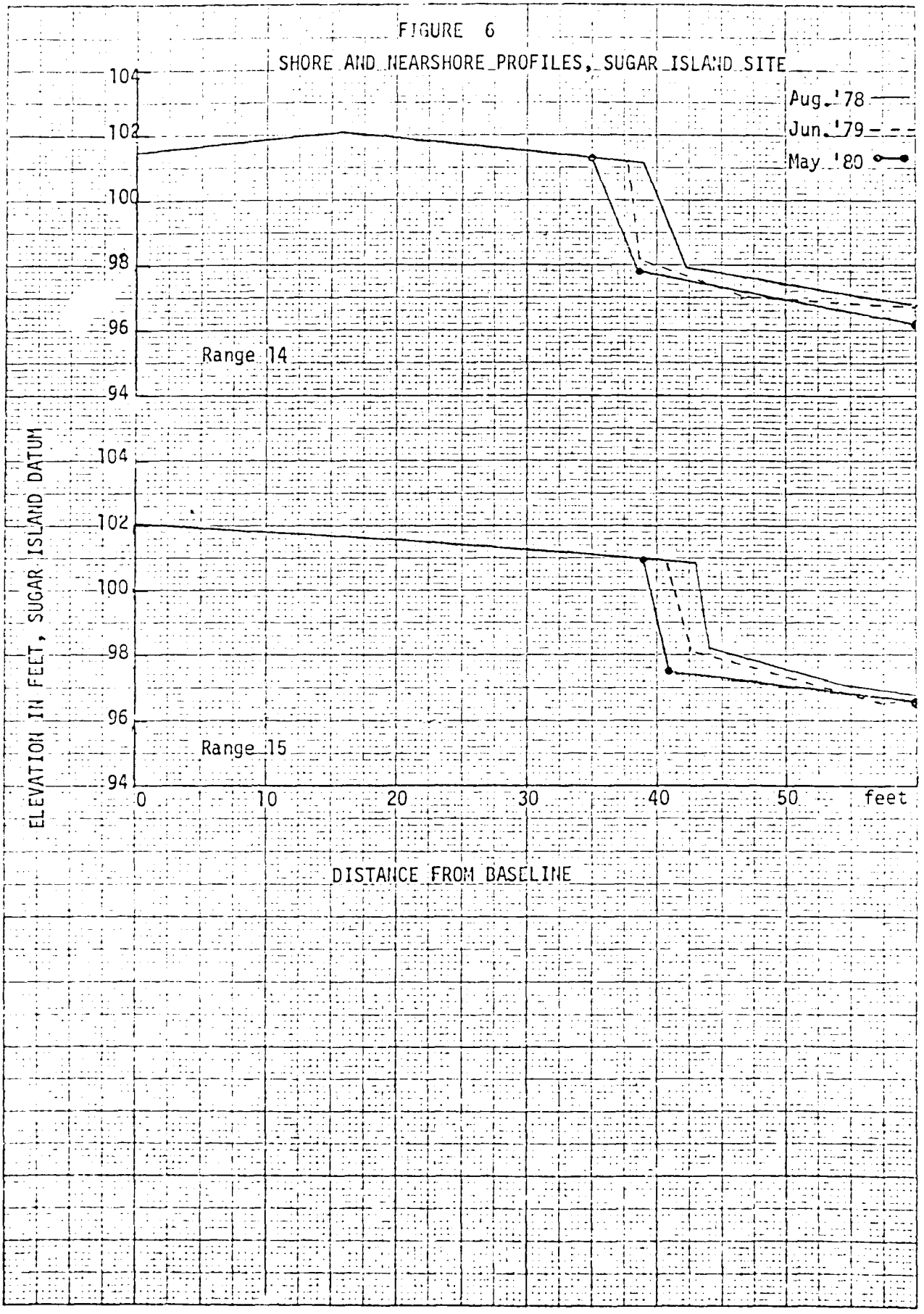


FIGURE 6

SHORE AND NEARSHORE PROFILES, SUGAR ISLAND SITE



7 through 13. Range 3 is protected with rip-rap and rock placed along the bluff and shoreline and no material nearshore alteration would be expected along this range. Ranges 1, 2, 4, 6 and 7 all show some recession of the shore area while Range 5 indicates some filling due to the migration of the sand berm located near this range. Water levels were high durir the summer of 1979 and erosive forces would have been applied at higher elevations of the shore and bluff during this period.

It is interesting to note here that no material nearshore recession has been reported in the earlier years of study with winter navigation present while some recession did occur during this period of no winter navigation.

FIGURE 7

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 1

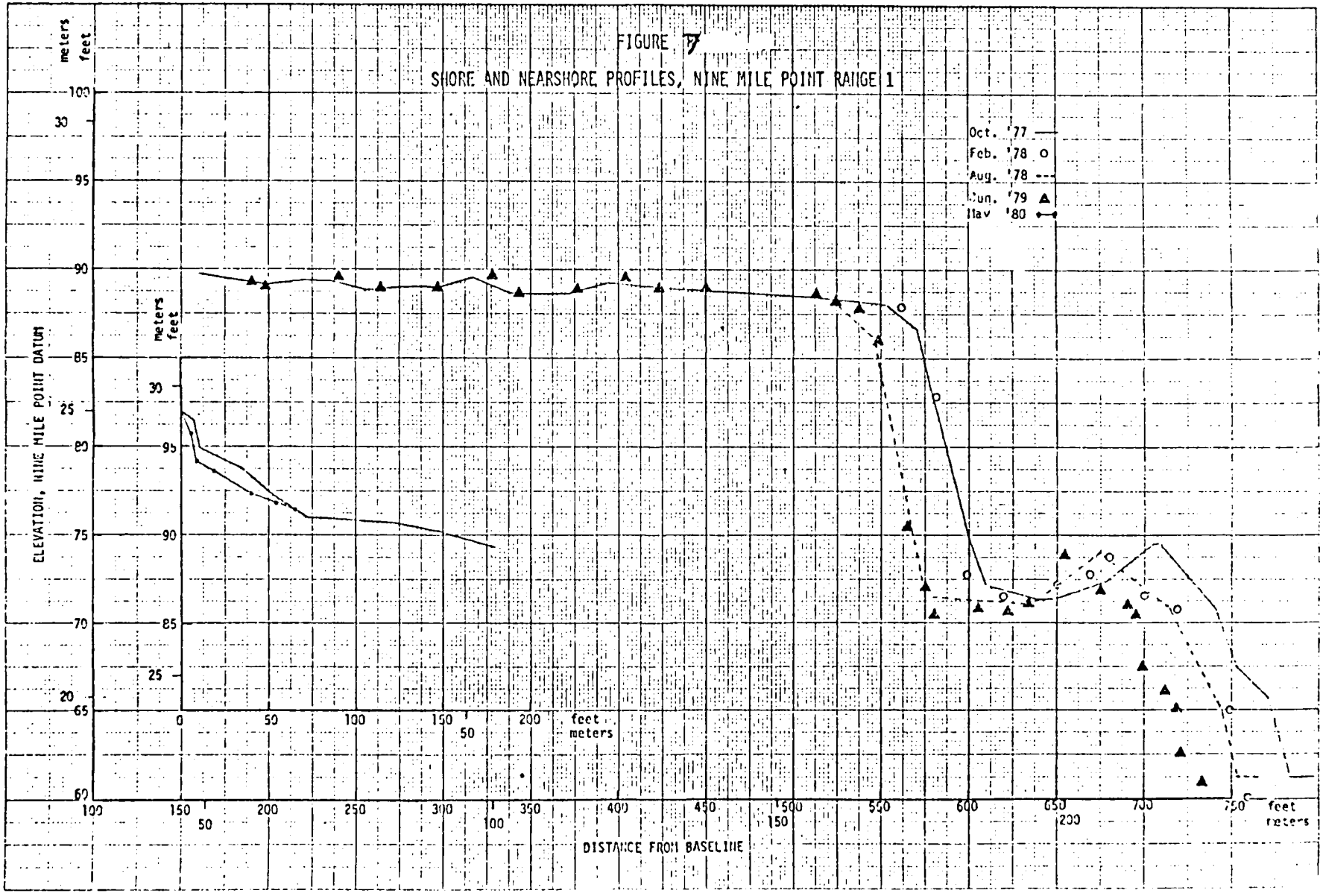


FIGURE 8

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 2

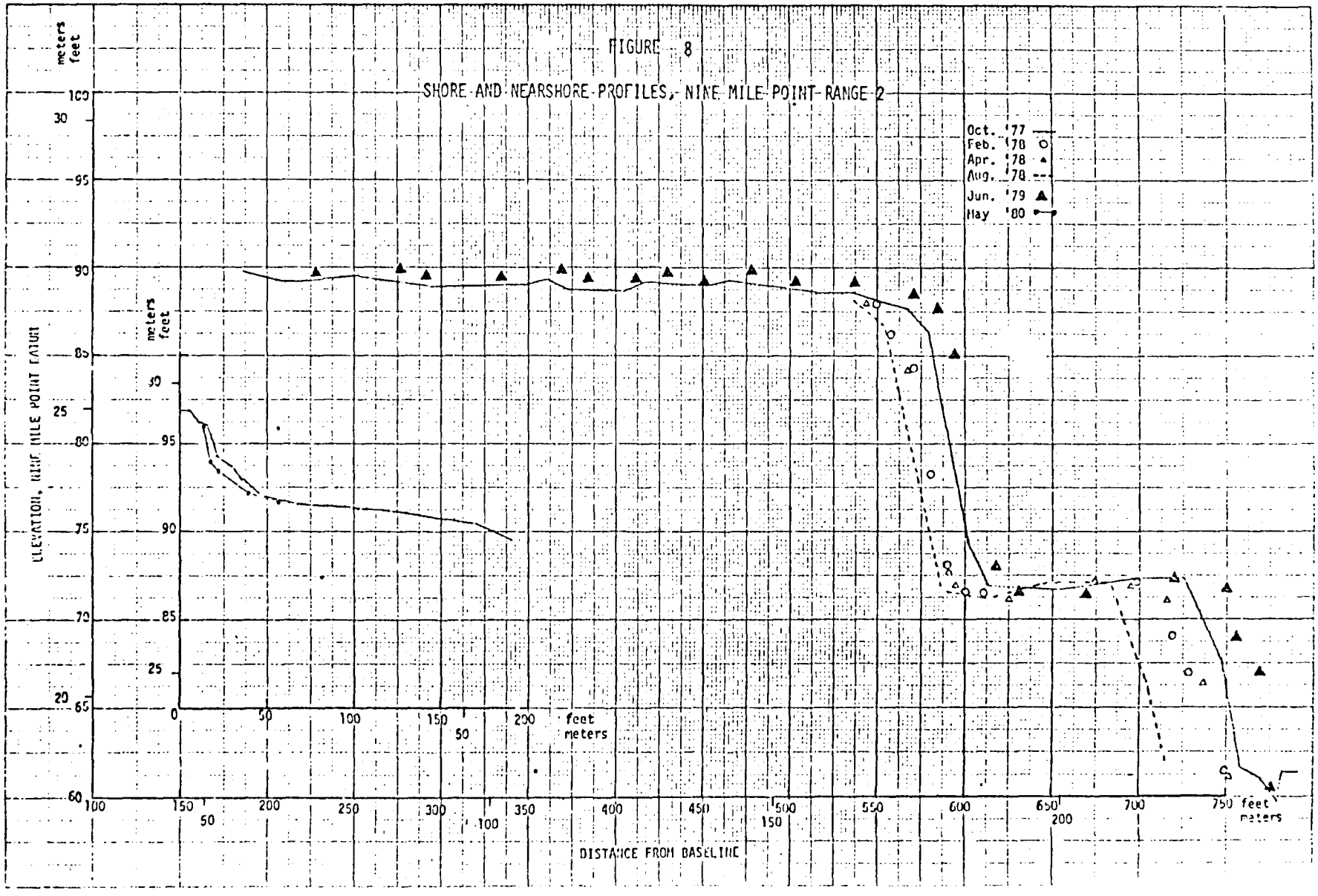


FIGURE 9

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 3

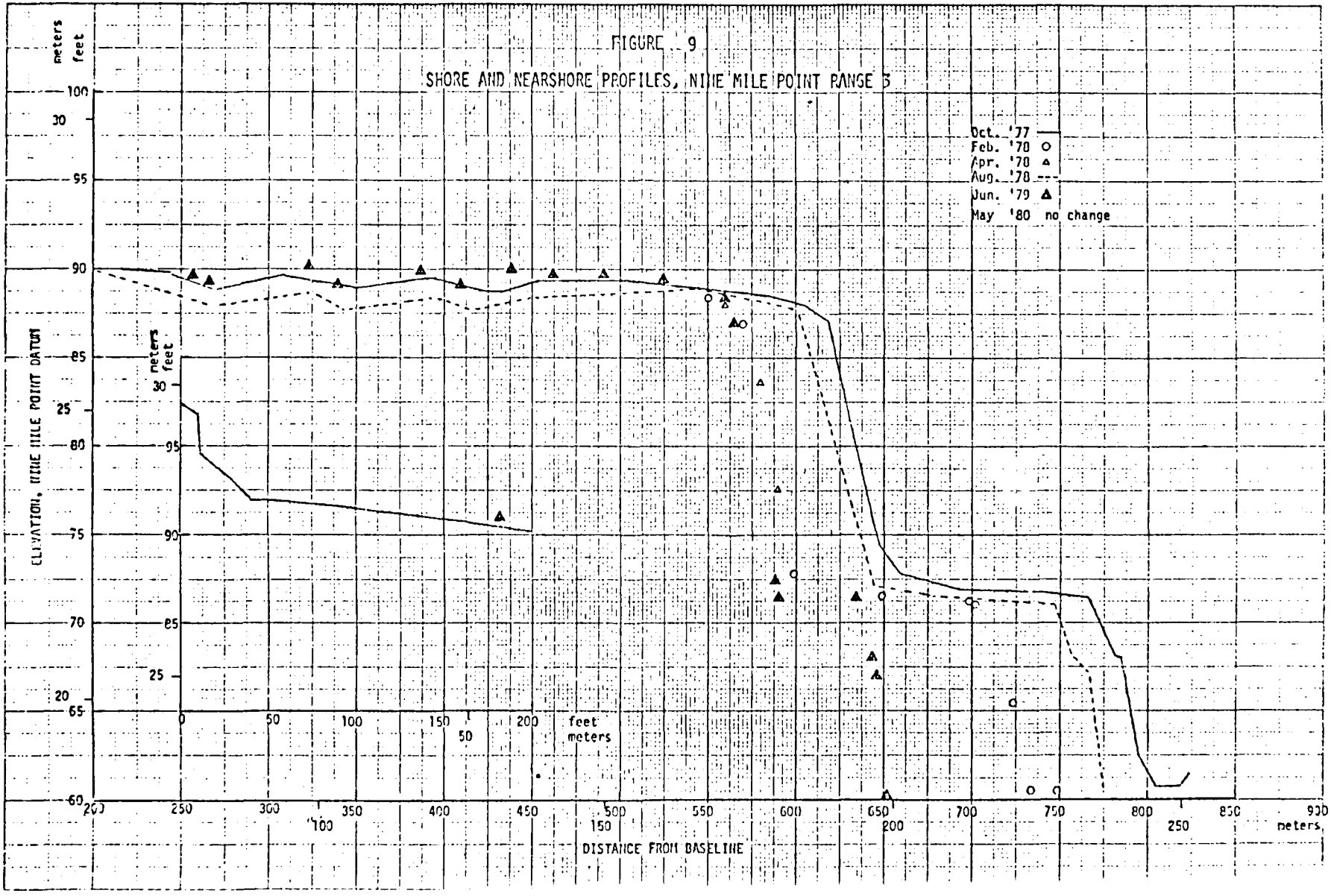


FIGURE 10

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 4

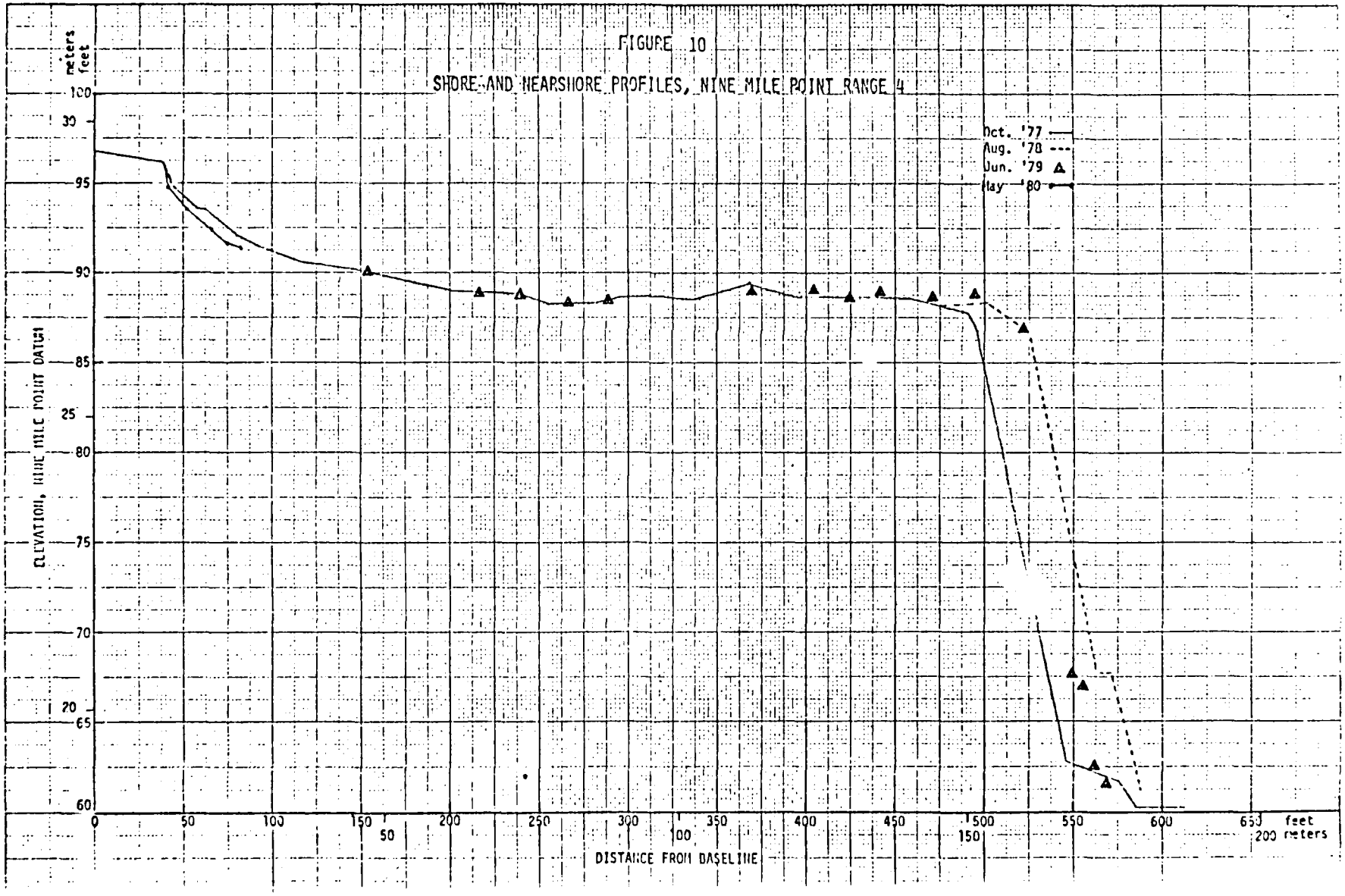


FIGURE 11

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 5

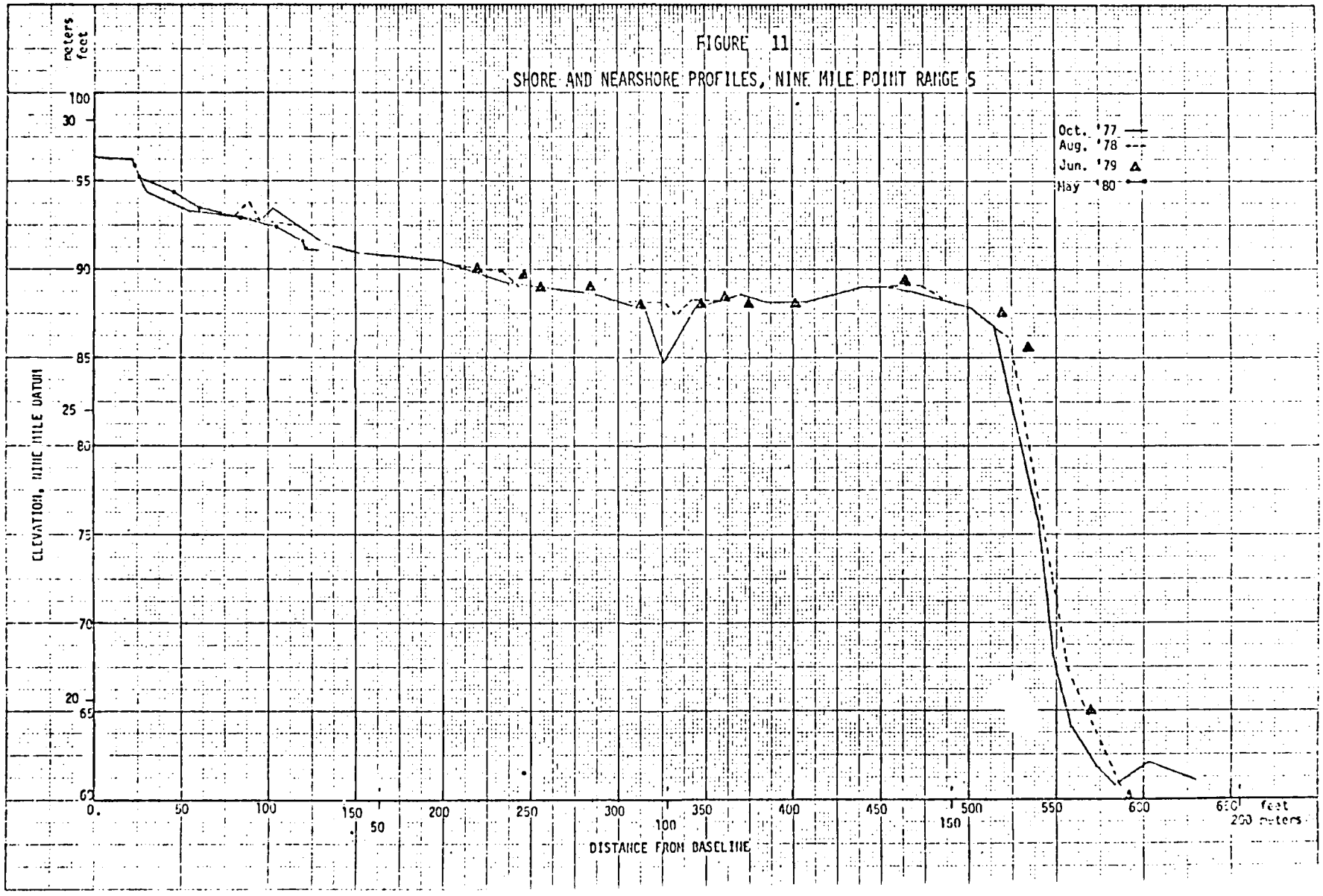


FIGURE 12

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 6

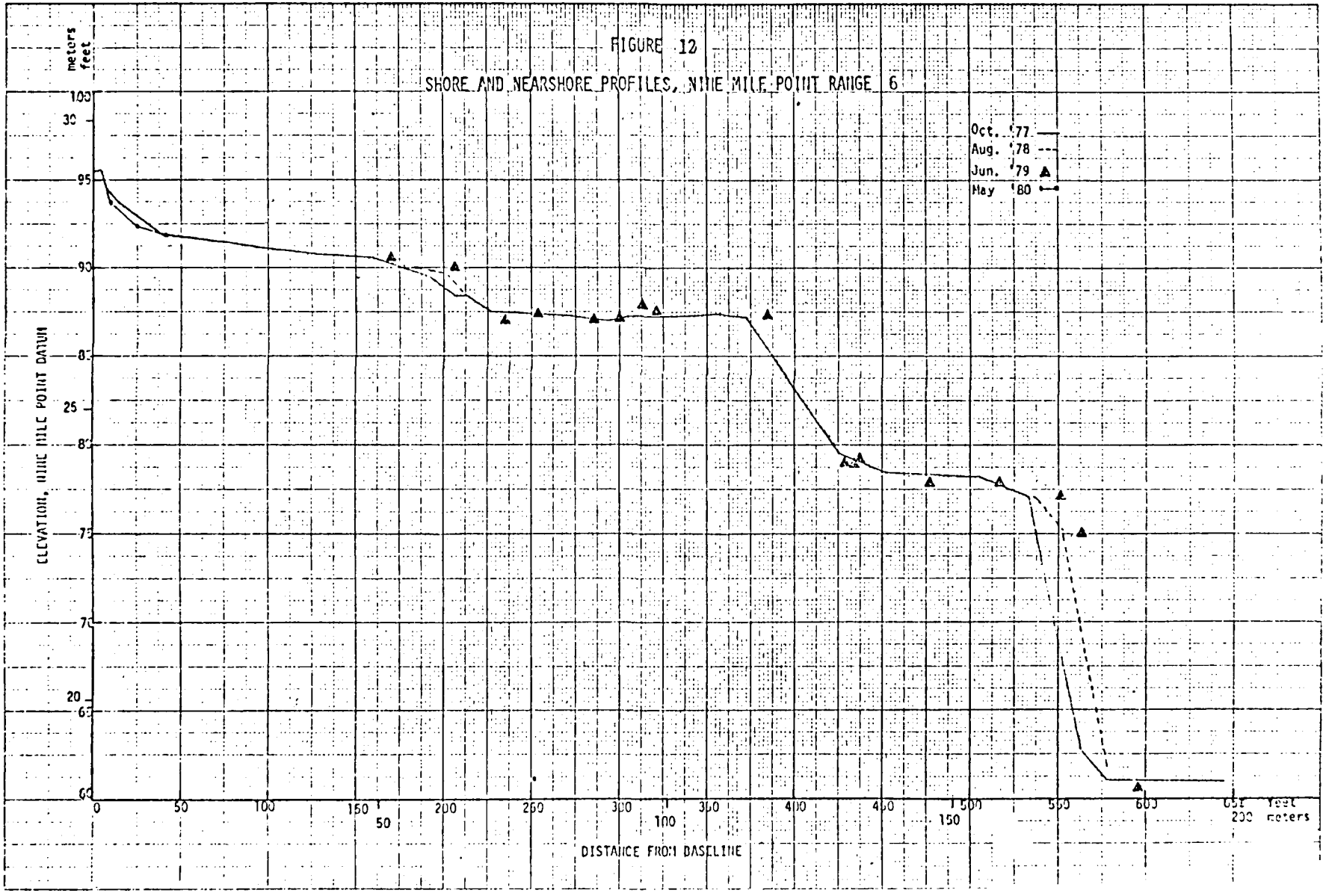
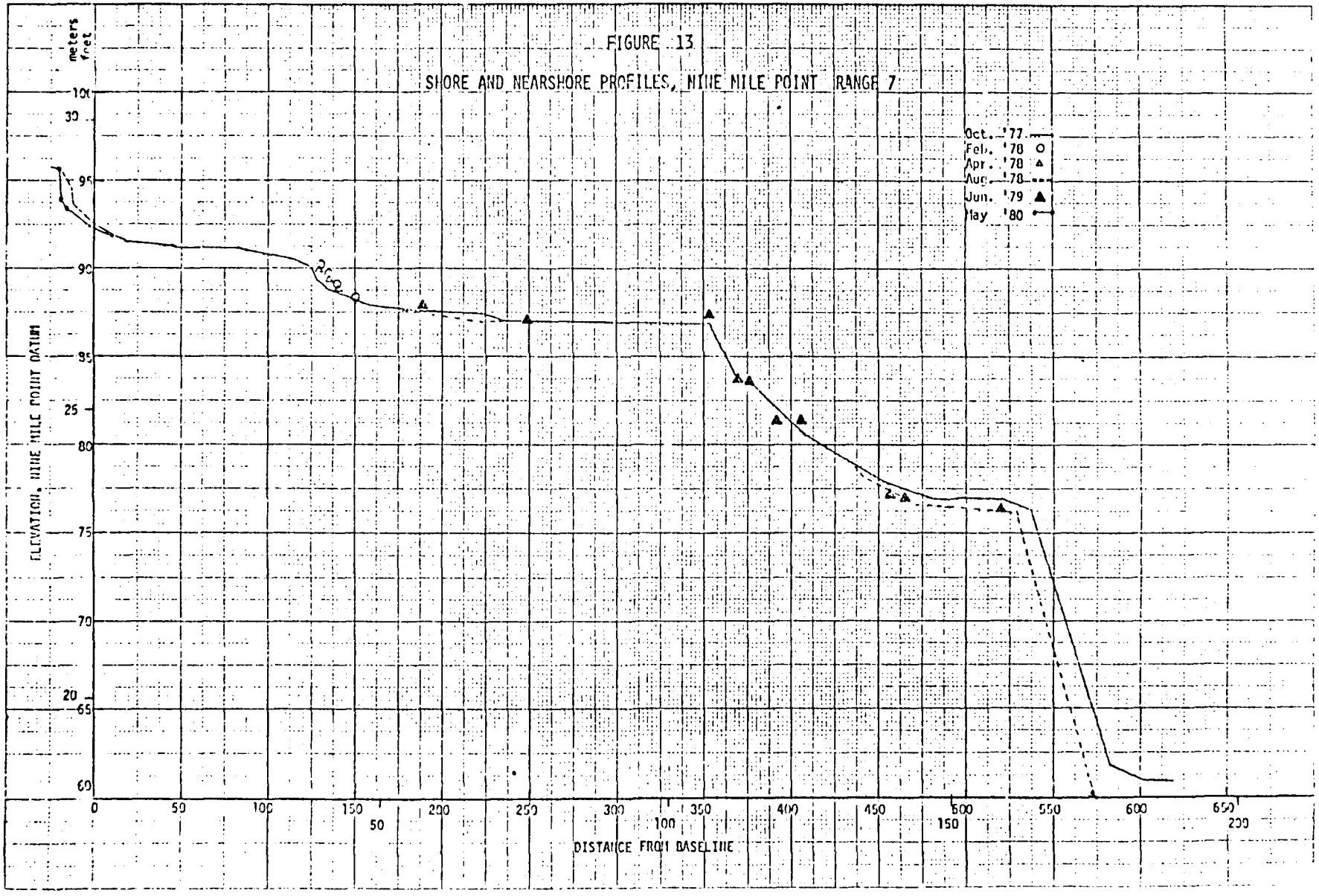


FIGURE 13

SHORE AND NEARSHORE PROFILES, NINE MILE POINT RANGE 7



CONCLUSIONS AND RECOMMENDATIONS

It is evident from the information reported here relative to similar data reported from previous years that nearshore and bluff recession continues at sites which have previously been reported as active. However, one site, which previously was relatively inactive now shows some erosion activity. Since winter navigation was essentially absent during this present study period and active during the periods covered by previous reports the combined evidence appears to be inadiquate to factor winter navigation effects, if any. If erosive forces are present relative to winter navigation activity they could only be factored by a more intensive study including both summer and winter periods at a much more frequent interval. Should a future monitoring program be established it is essential that the frequency of observations be considerably expanded.